IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS

May 31, 2002

In re Application of:	Conklin
Serial No.	09/441,318
Filed:	11/16/99
For:	TRANSGENIC PLANT WITH INCREASED EXPRESSION OF GDP-MANNOSE PYROPHOSPHORYLASE
Examiner:	Kubelik, A.
Art Unit:	1638
Attorney Docket No.:	BTI-41

APPEAL BRIEF

HONORABLE COMMISSIONER OF
PATENTS AND TRADEMARKS
Washington, D.C. 20231

Sir:

This application is before the Honorable Board of Appeals on appeal from the Final Rejection by the Examiner dated January 8, 2002, wherein claims 1-22 and 24-26 were finally rejected.

(1)
REAL PARTY IN INTEREST

An assignment of the invention claimed in this application from the Appellant to Boyce Thompson Institute for Plant Research, Inc., a State of New York corporation, is recorded in the U.S. Patent and Trademark Office microfilm records at Reel 010411, Frame

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited in the U.S. Postal Service as Certified Mail No: 001 1940 0001 4327 3921 with a return receipt requested, in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231 on May 31, 2002

Justin Wood

0603. Accordingly, the Real Party in Interest is Boyce Thompson Institute for Plant Research, Inc.

(2)
RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellant, the Appellant's legal representative, or Assignee, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending Appeal.

(3)
STATUS OF CLAIMS

Claims 1-22 and 24-26 are pending in the application; claim 23 was cancelled. Claims 1-22 and 24-26 stand finally rejected.

The Final Rejection of claims 1-22 and 24-26 is appealed. The Claims on Appeal are set forth in the Appendix to this brief.

(4)
STATUS OF AMENDMENTS AFTER FINAL REJECTION

A reply to the final office action was filed on April 1, 2002. All amendments presented in Applicant's reply dated April 1, 2002 have been entered for the purposes of this appeal.

(5)
SUMMARY OF THE INVENTION

A genetically engineered plant of the invention includes a recombinant nucleic acid sequence encoding a protein involved in Vitamin C biosynthesis. This protein preferably encodes GDP-mannose pyrophosphorylase. The genetically engineered plant is capable of

producing increased levels of Vitamin C. The plant also possesses increased resistance to environmental stresses compared to wild type plants. In another embodiment of the invention, a genetically engineered plant includes a recombinant nucleic acid encoding GDP-mannose pyrophosphorylase. The genetically engineered plant is capable of expressing the recombinant nucleic acid. It can also produce increased levels of Vitamin C. The genetically engineered plant has increased resistance to environmental stresses than wild type plants. Another embodiment of the invention is a method of increasing the endogenous level of Vitamin C produced in a plant includes the overexpression of an enzyme crucial to Vitamin C biosynthesis. This enzyme is preferably GDP-mannose pyrophosphorylase. Increasing the endogenous level of Vitamin C leads to increased resistance to environmental stresses. In another embodiment of the invention, a genetically engineered plant includes a mutant gene that encodes a form of GDP-mannose pyrophosphorylase.

(5A)

References Relied Upon by the Examiner

The Final Rejections of claims 1-22 and 24-26 are made under 35 U.S.C. § 112, first paragraph, and, as such, the Examiner does not rely upon any prior art references in the Final Rejection of the claims.

(6)

ISSUES

1. Is the specification enabling under 35 U.S.C. § 112, first paragraph, for claims 1-22 and 24-26?

2. Does the specification provide an adequate written description under 35 U.S.C. § 112, first paragraph, for claims 1-22 and 24-26?

(7)
GROUPING OF CLAIMS

The rejected claims do not stand or fall together, except as noted.

Claims 1-8 and 24 are argued as a group, and thus stand or fall together.

Clams 9-15 and 25 are argued as a group, and thus stand or fall together.

Claims 16-22 and 26 are argued as a group, and thus stand or fall together.

The claims on appeal are set forth in the Appendix to this brief.

(8)
ARGUMENTS

(8A)
The Specification Enables One of Ordinary Skill in the Art to Make and Use the Invention of Claims 1-22 and 24-26

Claims 1-22 and 24-26 stand finally rejected under 35 U.S.C. § 112, first paragraph, as not being enabled by the specification. Appellant disagrees and respectfully requests that this Board reverse the rejection.

Case Law

All questions of enablement are evaluated against the claimed subject matter. In re Moore, 439 F.2d 1232, 1236, 169 USPQ 236, 239 (C.C.P.A. 1971). The focus of the examination inquiry is whether the subject matter within the scope of the claim is enabled. In re Fisher, 427 F.2d 833, 166 USPQ 18, 24 (C.C.P.A. 1970).

The test for enablement is whether the disclosure, when originally filed, contained sufficient information regarding the subject matter of the claims as to enable those of ordinary skill in the pertinent art to make and use the invention. The standard is whether the experimentation necessary to practice the invention is undue or unreasonable. In re Wands, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988). *See also* U.S. v. Telectronics,

Inc., 857 F.2d 778, 785, 8 USPQ2d 1217, 1223 (Fed. Cir. 1988) ("The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation.") (emphasis added). A patent need not teach, and preferably omits, what is well known in the art. In re Buchner, 929 F.2d 660, 661, 18 USPQ2d 1331, 1332 (Fed. Cir. 1991); Hybritech, Inc. v. Monoclonal Antibodies , Inc., 802 F.2d 1367, 1384, 231 USPQ 81, 94 (Fed. Cir. 1986), *cert. denied*, 480 U.S. 947 (1987); Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co., 730 F.2d 1452, 1463, 221 USPQ 481, 489 (Fed. Cir. 1984).

The fact that experimentation may be complex does not necessarily make it undue, if the art typically engages in such experimentation. In re Certain Limited-Charge Cell Culture Microcarriers, 221 USPQ 1165, 1174 (Int'l Trade Comm'n 1983), *aff'd. sub nom.*, Massachusetts Institute of Technology v. A.B. Fortia, 774 F.2d 1104, 227 USPQ 428 (Fed. Cir. 1985). *See also* In re Wands, 858 F.2d at 737, 8 USPQ2d at 1404.

There are many factors to be considered when determining whether there is sufficient evidence to support a determination that a disclosure does not satisfy the enablement requirement and whether any necessary experimentation is "undue." These factors include, but are not limited to: the breadth of the claims; the nature of the invention; the state of the prior art; the level of one of ordinary skill; the level of predictability in the art; the amount of direction provided by the inventor; the existence of working examples; and the quantity of experimentation needed to make or use the invention based on the content of the disclosure. In re Wands, 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988) (reversing the PTO's determination that claims directed to methods for detection of hepatitis B surface antigens did not satisfy the enablement requirement).

In Wands, the court noted that there was no disagreement as to the facts, but merely a disagreement as to the interpretation of the data and the conclusion to be made from the facts. In re Wands, 858 F.2d at 736-40, 8 USPQ2d at 1403-07. The Court held that the specification was enabling with respect to the claims at issue and found that "there was considerable direction and guidance" in the specification; there was "a high level of skill in the art at the time the application was filed;" and "all of the methods needed to practice the invention were well known." 858 F.2d at 740, 8 USPQ2d at 1406. After considering all the factors related to the enablement issue, the court concluded that "it would not require undue experimentation to

obtain antibodies needed to practice the claimed invention." Id., 858 F.2d at 740, 8 USPQ2d at 1407.

A conclusion of lack of enablement means that, based on the evidence regarding each of the above factors, the specification, at the time the application was filed, would not have taught one skilled in the art how to make and/or use the full scope of the claimed invention without undue experimentation. In re Wright, 999 F.2d 1557,1562, 27 USPQ2d 1510, 1513 (Fed. Cir. 1993). However, the determination that "undue experimentation" would have been needed to make and use the claimed invention is not a single, simple factual determination. Rather, it is a conclusion reached by weighing all the above noted factual considerations. In re Wands, 858 F.2d at 737, 8 USPQ2d at 1404. It is improper to conclude that a disclosure is not enabling based on an analysis of only one of the above factors, while ignoring one or more of the others. The Examiner's analysis must consider all the evidence related to each of these factors, and any conclusion of non-enablement must be based on the evidence as a whole. Id., 858 F.2d at 740, 8 USPQ2d at 1407.

Claims 1-8 and 24

Applicant's independent claim 1, as amended, is directed to a genetically engineered plant, comprising a recombinant nucleic acid that encodes an enzyme in a plant Vitamin C biosynthesis pathway, wherein said enzyme is selected from a group of four enzymes. As such, claim 1 (and dependent claims 2-8 and 24) is not drawn to a method, and does not recite the limitation of overexpression. Further, claim 1, as amended, is expressly limited to a group of only four enzymes.

The Examiner asserts that the instant specification, while discussing expression of an *Arabidopsis* gene encoding GMPase in vtcl mutants of *Arabidopsis*, fails to provide guidance for successful overexpression of that gene in wild-type plants, and that overexpression of a gene in plants is unpredictable. The Examiner thus concludes that, as Applicant's gene

encoding GMPase was not expressed in wild-type plants, the unpredictability associated with overexpression of genes in plants has not been overcome.

The Board's attention is drawn to the fact that Applicant's claims, as amended, do not encompass expression or overexpression of any gene in "wild-type plants". Rather, the claims are directed to genetically engineered plants, not wild-type plants. Therefore, no enablement regarding expression or overexpression of a gene in wild-type plants is required. Further, "overexpression" is not a feature of any of the claims, as amended. Moreover, it is respectfully submitted that the Examiner's assertion that the unpredictability associated with overexpression of genes in plants has not been overcome is mistaken, in that Applicant's gene encoding GMPase was transformed into plants, thereby generating genetically engineered plants having increased levels of Vitamin C, relative to the progenitor plants. See Applicant's specification at page 13, line 24, through page 17, line 3. Thus, clearly, Applicant's GMPase can be expressed in plants, and clearly such plants have increased levels of Vitamin C, thus overcoming any alleged unpredictability. Although in the past, in some cases expression of foreign genes in plants has been unpredictable, the current state of the art is such that, using routine methods that are well known in the art, one of ordinary skill in the art can predictably transfer into and express virtually any gene (including bacterial genes and other genes of non-plant origin) in plants (including both monocots and dicots). Indeed, the Examiner appears to have admitted such in applying the rejections under sections 102 and 103.

The Examiner asserts further that: 1) the only gene encoding GMPase taught in the instant specification is from *Arabidopsis*, 2) the instant specification fails to teach any other gene encoding any other enzyme involved in vitamin C biosynthesis, 3) it also fails to teach or suggest any method of overexpressing any enzyme other than by transformation of a gene into a plant, and 4) fails to provide guidance for the sequence of the gene encoding GMPase. Thus, the Examiner concludes that the invention appears to employ novel plasmid encoding GMPase contained in microorganisms, and that a deposit is required for enablement purposes.

It is respectfully submitted that genes encoding GMPase (including that of *Arabidopsis* and other species), as well as the other enzymes in the Vitamin C pathway, are well known in the art and, as such, are not required to be disclosed in Applicant's specification. However, Applicant's Figure 1 and the specification at page 4, lines 12-16, disclose the enzymes in the Vitamin C pathway. Further, Applicant's specification provides ample guidance for the sequence of the gene encoding GMPase at page 11, lines 5-8, wherein the GenBank accession number is provided. Thus, one of ordinary skill in the art would know the sequence of the GDP-mannose pyrophosphorylase, as it is well known in the art, and ample guidance thereto also is disclosed in Applicant's specification. Finally, the claims, as amended, do not encompass any method for expressing a recombinant gene in a plant, other than that of transformation of a gene into a plant. Therefore, no guidance regarding any other methods is required.

In view of the above, the Board is requested to note that the specification contains sufficient matter to support the genetically engineered plants and the method of generating such plants, as presently claimed. In particular, the specification discloses the appropriate elements of the claimed plants together with the appropriate techniques that would effectively produce such plants. Indeed, the specification provides one skilled in the art with the detailed steps deemed necessary to duplicate the claimed method and genetically engineered plants, including methods for generating mutations in other genes encoding enzymes in the Vitamin C biosynthetic pathway, methods for identifying and isolating genes, methods for transforming plants to express genes, and methods for screening and selecting plants having increased levels of Vitamin C.

In addition, the Applicant has filed a continuation-in-part application, serial number 09/909,600, filed July 20, 2001, entitled "TRANSGENIC PLANTS WITH INCREASED EXPRESSION OF *VTC4* GENE", which claims priority from the present application. In that application, the same methods were used to identify and clone another gene in the Vitamin C

pathway. The same techniques were used to obtain another gene in the pathway and no undue experimentation was required.

Thus, it is respectfully submitted that the disclosure complies with section 112 fully, in that the description of the various elements of the genetically engineered plants, together with the steps relating to the novel process for making such plants, provides a full, clear and concise instruction to any person reasonably skilled in the art, thus enabling him to make and use the invention without undue experimentation.

Accordingly, Appellant respectfully requests that this Board reverse the rejection of claims 1-8 and 24 under 35 U.S.C. § 112, first paragraph, for lack of enablement, in view of the above remarks.

Claims 9-15 and 25

The arguments raised above in claims 1 concerning enablement are also applicable here and are herein incorporated by reference.

Applicant's independent claim 9 is directed to a genetically engineered plant, comprising a recombinant nucleic acid that encodes GDP-mannose pyrophosphorylase. As such, claim 9 (and dependent claims 10-15 and 25) does not recite the limitation of overexpression. Further, claim 9 is expressly limited to a single enzyme.

As discussed above, Applicant's specification provides ample guidance for the sequence of the gene encoding GMPase at page 11, lines 5-8, wherein the GenBank accession number is provided. Thus, one of ordinary skill in the art would know the sequence of the GDP-mannose pyrophosphorylase, as it is well known in the art, and ample guidance thereto also is disclosed in Applicant's specification.

Accordingly, Appellant respectfully requests that this Board reverse the rejection of claims 9-15 and 25 under 35 U.S.C. § 112, first paragraph, for lack of enablement, in view of the above remarks.

Claims 16-22 and 26

The arguments raised above in claims 1 and 9 concerning enablement are also applicable here and are herein incorporated by reference.

Independent claim 16, as amended, is directed to a method of increasing the level of Vitamin C in a plant comprising the step of engineering said plant to express an enzyme in a plant Vitamin C biosynthesis pathway, wherein said enzyme is selected from a group of four enzymes. As such, claim 16 (and dependent claims 17-22 and 26) is directed to a method, but it does not recite the limitation of overexpression. Further, claim 16, as amended, is expressly limited to a group of only four enzymes.

The Examiner asserts that the instant specification fails to teach or suggest any method of overexpressing any enzyme other than by transformation of a gene into a plant. The genes encoding GMPase (including that of *Arabidopsis* and other species), as well as the other enzymes in the Vitamin C pathway, are well known in the art and, as such, are not required to be disclosed in Applicant's specification. In addition, claim 16, as amended, does not encompass any method for expressing a recombinant gene in a plant, other than that of transformation of a gene into a plant. Therefore, no guidance regarding any other methods is required.

Accordingly, Appellant respectfully requests that this Board reverse the rejection of claims 16-22 and 26 under 35 U.S.C. § 112, first paragraph, for lack of enablement, in view of the above remarks.

(8B)

The Disclosure Conveys That The Inventor Had Possession of the Invention of Claims 1-22 and 24-26

Claims 1-22 and 24-26 stand finally rejected under 35 U.S.C. § 112, first paragraph, as not being supported by an adequate written description. Appellant disagrees and respectfully requests that this Board reverse the rejection.

Case Law

The test for compliance with the written description requirement is whether the Appellants' disclosure as originally filed reasonably conveys to the artisan that the inventor had possession at that time of the later claimed subject matter, rather than the presence or absence of literal support in the specification for the claim language. Ralston Purina Co. v. Far-Mar-Co., Inc., 772 F.2d 1570, 1575, 227 USPQ 177, 179 (Fed. Cir. 1985) (*quoting* In re Kaslow, 707 F.2d 1366, 1375, 217 USPQ 1089, 1096 (Fed. Cir. 1983). The standard is whether the written description allows persons of ordinary skill in the art to recognize that the patent applicant invented what is claimed. In re Gosteli, 872 F.2d 1008, 1012, 10 USPQ2d 1614, 1618 (Fed. Cir. 1989).

Whenever the issue arises, the fundamental factual inquiry is whether a claim defines an invention that is clearly conveyed to those skilled in the art at the time the application was filed. However, the subject matter of the claim need not be described literally (*i.e.*, using the same terms or *in haec verba*) in order for the disclosure to satisfy the description requirement. *See* In re Kaslow, 707 F.2d 1366, 1375, 217 USPQ 1089, 1096 (Fed. Cir. 1983). Further, the disclosure must be read in light of the knowledge of those skilled in the art, as evidenced by references available to the public prior to the filing date. In re Lange, 644 F.2d 856, 863, 209 USPQ 288, 294 (C.C.P.A. 1981).

Claims 1-8 and 24

The Examiner maintains that the specification does not describe which enzymes are crucial for vitamin C biosynthesis, their enzymatic activity, or the sequence of any gene encoding any enzyme involved in vitamin C biosynthesis, including that of any gene encoding GMPase, and does not demonstrate the isolation of GMPase genes from plants other than *Arabidopsis*. Therefore, the Examiner concludes that, given the lack of written description in the specification with regard to the structural and physical characteristics of the claimed plants and methods, and given the high level of unpredictability in this art, one skilled in the art would not have been in possession of the genus claimed at the time this application was filed.

Claim 1 discloses "a genetically engineered plant, or portion thereof, comprising a recombinant nucleic acid that encodes an enzyme in a plant Vitamin C biosynthesis pathway, wherein said enzyme is selected from the group consisting of phosphoglucose isomerase, phosphomannomutase, GDP-mannose pyrophosphorylase, and GDP-D-mannose-3,5-epimerase." It is respectfully submitted that genes encoding GMPase (including that of *Arabidopsis* and other species), as well as the other enzymes in the Vitamin C pathway, are well known in the art and, as such, are not required to be disclosed in Applicant's specification. However, Applicant's Figure 1 and the specification at page 4, lines 12-16, disclose phosphoglucose isomerase, phosphomannomutase, GDP-mannose pyrophosphorylase, and GDP-D-mannose-3,5-epimerase, the four enzymes listed in claim 1.

Further, Applicant's specification provides ample guidance for the sequence of the gene encoding GMPase at page 11, lines 5-8, wherein the GenBank accession number is provided. Thus, one of ordinary skill in the art would know that Applicant was in possession of the sequence of the GDP-mannose pyrophosphorylase, as it is well known in the art, and ample guidance thereto also is disclosed in Applicant's specification.

Moreover, it is respectfully submitted that the Examiner's assertion that the unpredictability associated with overexpression of genes in plants has not been overcome is

mistaken, in that Applicant's gene encoding GMPase was transformed into plants, thereby generating genetically engineered plants having increased levels of Vitamin C, relative to the progenitor plants. See Applicant's specification at page 13, line 24, through page 17, line 3. Thus, clearly, Applicant's GMPase can be expressed in plants, and clearly such plants have increased levels of Vitamin C, thus overcoming any alleged unpredictability.

Accordingly, Appellant respectfully requests that this Board reverse the rejection of claims 1-8 and 24 under 35 U.S.C. § 112, first paragraph, for lack of a sufficient written description, in view of the above remarks.

Claims 9-15 and 25

The arguments raised above in claim 1 concerning written description are also applicable here and are herein incorporated by reference.

Claim 9 discloses "a genetically engineered plant, or portion thereof, comprising a recombinant nucleic acid that encodes GDP-mannose pyrophosphorylase". Genes encoding GMPase (including that of *Arabidopsis* and other species), as well as the other enzymes in the Vitamin C pathway, are well known in the art and, as such, are not required to be disclosed in Applicant's specification. However, Applicant's Figure 1 and the specification at page 4, lines 12-16, specifically disclose GDP-mannose pyrophsophorylase. Further, Applicant's specification provides ample guidance for the sequence of the gene encoding GMPase at page 11, lines 5-8, wherein the GenBank accession number is provided. Thus, one of ordinary skill in the art would know that Applicant was in possession of the sequence of the GDP-mannose pyrophosphorylase, as it is well known in the art, and ample guidance thereto also is disclosed in Applicant's specification.

Accordingly, Appellant respectfully requests that this Board reverse the rejection of claims 9-15 and 25 under 35 U.S.C. § 112, first paragraph, for lack of a sufficient written description, in view of the above remarks.

Claims 16-22 and 26

The arguments raised above in claim 1 and claim 9 concerning written description are also applicable here and are herein incorporated by reference.

Claim 16 discloses "a method of increasing the level of Vitamin C produced in a plant, or portion thereof, comprising the step of engineering said plant, or portion thereof, to express a recombinant nucleic acid that encodes an enzyme in a plant Vitamin C biosynthesis pathway, wherein said enzyme is selected from the group consisting of phosphoglucose isomerase, phosphomannomutase, GDP-mannose pyrophosphorylase, and GDP-D-mannose-3,5-epimerase." Applicant's Figure 1 and the specification at page 4, lines 12-16, disclose the four enzymes in the Vitamin C pathway listed here.

Moreover, it is respectfully submitted that the Examiner's assertion that the unpredictability associated with overexpression of genes in plants has not been overcome is mistaken, in that Applicant's gene encoding GMPase was transformed into plants, thereby generating genetically engineered plants having increased levels of Vitamin C, relative to the progenitor plants. See Applicant's specification at page 13, line 24, through page 17, line 3. Thus, clearly, Applicant's GMPase can be expressed in plants, and clearly such plants have increased levels of Vitamin C, thus overcoming any alleged unpredictability.

Accordingly, Appellant respectfully requests that this Board reverse the rejection of claims 16-22 and 26 under 35 U.S.C. § 112, first paragraph, for lack of a sufficient written description, in view of the above remarks.

(9)
CONCLUSION

In view of the arguments set forth in this brief, Appellant respectfully requests that this Board reverse the rejections of claims 1-22 and 24-26 under 35 U.S.C. § 112, first paragraph, and allow the application and pending claims to issue.

(10)
ADDITIONAL COMMENT AND RESERVATION

Appellant believes it has responded to all of the reasons for rejection which it can discern in the Office Action. However, Appellant reserves the right to respond with a supplementary argument to any reasons for rejection which were not responded to in this brief, if the Examiner should assert in his Answer that any were not responded to herein.

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APPENDIX
Claims on Appeal

1. A genetically engineered plant, or portion thereof, comprising a recombinant nucleic acid that encodes an enzyme in a plant Vitamin C biosynthesis pathway, wherein said enzyme is selected from the group consisting of phosphoglucose isomerase, phosphomannomutase, GDP-mannose pyrophosphorylase, and GDP-D-mannose-3,5-epimerase.

2. The genetically engineered plant of claim 1 wherein said plant, or portion thereof, is a dicot.

3. The genetically engineered plant of claim 1 wherein said genetically engineered plant is *Arabidopsis thaliana*.

4. The genetically engineered plant, or portion thereof, of claim 1 wherein said nucleic acid comprises a polynucleotide that encodes GDP-mannose pyrophosphorylase.

5. The genetically engineered plant of claim 1 wherein said genetically engineered plant, or portion thereof, expresses said recombinant nucleic acid.

6. The genetically engineered plant of claim 1 wherein said genetically engineered plant, or portion thereof, produces increased levels of Vitamin C, relative to a progenitor plant from which said genetically engineered plant is derived.

7. The genetically engineered plant of claim 1 wherein said genetically engineered plant, or portion thereof, has increased resistance to environmental stress compared to a plant of the same species without said recombinant nucleic acid wherein said environmental stress is selected from the group consisting of drought, cold, UV radiation, air pollution, salts, heavy metals and reactive oxygen species.

8. The genetically engineered plant of claim 1 wherein said genetically engineered plant, or portion thereof, is edible.

9. A genetically engineered plant, or portion thereof, comprising a recombinant nucleic acid that encodes GDP-mannose pyrophosphorylase.

10. The genetically engineered plant of claim 9 wherein said genetically engineered plant, or portion thereof, is a dicot.

11. The genetically engineered plant of claim 9 wherein said genetically engineered plant is *Arabidopsis thaliana*.

12. The genetically engineered plant of claim 9 wherein said genetically engineered plant, or portion thereof, expresses said recombinant nucleic acid.

13. The genetically engineered plant of claim 9 wherein said genetically engineered plant, or portion thereof, produces increased levels of Vitamin C, relative to a progenitor plant from which said genetically engineered plant is derived.

14. The genetically engineered plant of claim 9 wherein said genetically engineered plant, or portion thereof, has increased resistance to environmental stress compared to a plant of the same species without said recombinant nucleic acid wherein said environmental stress is selected from the group consisting of drought, cold, UV radiation, air pollution, salts, heavy metals and reactive oxygen species.

15. The genetically engineered plant of claim 9 wherein said genetically engineered plant, or portion thereof, is edible.

16. A method of increasing the level of Vitamin C produced in a plant, or portion thereof, comprising the step of:

engineering said plant, or portion thereof, to express a recombinant nucleic acid that encodes an enzyme in a plant Vitamin C biosynthesis pathway, wherein said enzyme is selected from the group consisting of phosphoglucose isomerase, phosphomannomutase, GDP-mannose pyrophosphorylase, and GDP-D-mannose-3,5-epimerase.

17. The method of claim 16 wherein said enzyme is GDP-mannose pyrophosphorylase.

18. The method of claim 16 wherein said plant, or portion thereof, is a dicot.

19. The method of claim 16 wherein said plant is *Arabidopsis thaliana*.

20. The method of claim 16 wherein said plant, or portion thereof, has increased antioxidation capacity, relative to a progenitor plant from which said genetically engineered plant is derived.

21. The method of claim 16 wherein said plant, or portion thereof, has increased resistance to environmental stress compared to a plant of the same species without said recombinant nucleic acid wherein said environmental stress is selected from the group consisting of drought, cold, UV radiation, air pollution, salts, heavy metals and reactive oxygen species.

22. The method of claim 16 wherein said method produces a plant, or portion thereof, which is edible.

24. The genetically engineered plant of claim 4, wherein said polynucleotide comprises GenBank accession number T46645.

25. The genetically engineered plant of claim 9, wherein said nucleic acid comprises GenBank accession number T46645.

26. The method of claim 17, wherein said nucleic acid comprises GenBank accession number T46645.